U.S. Geological Survey Proposal

B: Streambed-Sediment Near Deer Trail, Colorado

Base Program: Streambed-Sediment Quality

Question:

Are biosolids applications on the Metro properties near Deer Trail adversely affecting the quality of the surface water in the vicinity?

Concerns:

Biosolids applied to the land surface could affect surface-water quality directly through 1) contaminated inflow or 2) runoff over contaminated soils or sediments (remobilization). Biosolids can also affect surface-water quality indirectly through 1) tilling that mobilizes or changes surface constituents or surface characteristics, 2) inflow, baseflow, or recharge to surface water from contaminated ground water, or 3) contributions to natural processes such as nitrification.

Contaminated surface water could contaminate downstream, previously uncontaminated 1) surface water (ponds or streams), 2) stream-bed sediments, 3) alluvial aquifers, or 4) bedrock water-supply aquifers in aquifer-recharge zones.

Objectives:

To determine whether concentrations of nitrogen, phosphorus, arsenic, bismuth, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, silver, and zinc, and organic carbon in bed sediments derived from (or transported through) biosolids-application properties are significantly higher than in bed sediments derived from nearby farmed properties without biosolids.

Approach:

Sediment deposited in stream channels or low-lying areas will be sampled to evaluate the potential for downstream surface-water contamination from biosolids applications. Sediment chemistry will be used as an indirect indication of surface-water quality because: 1) in general, the stream channels in this area only have flow immediately after rainfall when sampling the stream water is not practical; 2) concentrations of heavy metals are likely to be highest in the bed sediment; and 3) bed sediments can be remobilized during subsequent rainfall runoff and transported downstream.

A DCP site (DTX2) will be maintained by the USGS near the paired drainage basins to provide timely precipitation information to the USGS office in Denver. Note that during 1999-2003, rainfall conditions did not always produce enough runoff deposits in both basins for sample collection. Therefore, the USGS might not be able to collect even a

single pair of sediment samples every year during 2005-2010. If runoff is sufficient and field teams are available, recently deposited bed sediment from the paired drainage basins will be sampled after rainfall once each year for heavy metals, organic carbon, and nutrients. Analyses will include arsenic, bismuth, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, silver, and zinc, organic carbon, total nitrogen, and total phosphorus. Samples will be collected using appropriate USGS protocols. A field replicate will be analyzed with each sample pair (if sufficient sample material could be collected) to enable sample variability (laboratory plus field) to be evaluated.

Data will be compared to determine if concentrations are significantly larger in bed sediments from biosolids-application properties than concentrations in sediment from non-biosolids properties.

Monitoring sites:

Long-term monitoring sites were selected both on and off the MWRD property on the basis of field characteristics in 1999. Geology, drainage area, land use, rainfall, and channel morphology were criteria used to identify comparable drainages for this paired sampling. Sampling will continue at these locations for continuity with the data collected 1999-2004.

Benefits:

This approach will yield data useful for objectively evaluating bed-sediment chemistry (for metals, carbon, and nutrients) and the potential for downstream contamination. Monitoring bed-sediment quality is a more cost-effective approach than sampling surface-water runoff because less equipment is required and more representative information can be obtained from the samples. “Background” (pre-biosolids) sediment or water chemistry can’t be determined because biosolids have been applied at this site for several years, but the inter-basin comparison enables an objective evaluation of possible biosolids effects on inorganic chemistry.

Limitations:

This approach will not enable inferences about all aspects of surface-water quality, nor predict surface-water concentrations. Nutrient concentrations associated with the sediment can be measured, but are unlikely to represent or indicate stream concentrations, or possibly even runoff-sediment chemistry. This approach also will not evaluate sedimentation rates or quantity of bed sediment transported by runoff, although the USGS could (for an additional cost) determine sediment transport directly through field measurements or indirectly through aerial-photo comparisons.

It is possible that air-transported material also could affect surface-water and bed-sediment concentrations. However, the streams usually don’t have water at the time when surface materials (like biosolids) are dry enough to be transported by wind. The major transport of biosolids to surface water is likely from water. The USGS has a number of possible approaches to monitor the chemistry and amount of air-transported material, and proposes air monitoring as a separate study element.

Sediment chemistry and deposition will not be uniform throughout the area. Sampling a single drainage pair per storm will enable useful comparisons, but give little insight into the

variability of sediment chemistry throughout the area. Sampling additional drainage pairs after the same storm would enable a more significant (and quantitative) evaluation of runoff-sediment chemistry throughout the Metro property.

In general, comparing bed-sediment chemistry downgradient from MWRD property to bed-sediment chemistry upgradient from MWRD property in the same drainage is 1) often not feasible because many of the drainage basins head (begin) on Metro property, and 2) unlikely to result in an unbiased evaluation because the comparison criteria (such as same geology, land use, and drainage area) can't be met.

Access issues could seriously undermine this approach. The USGS sampling team would need to be able to access private property neighboring the Metro properties to collect the sediment samples from the non-biosolids drainages. In addition, USGS sampling teams would have to access the area fairly soon after rainfall had caused flow in the drainages if nutrient and organic carbon samples are to be representative because concentrations (especially nitrogen) will change rapidly. Vehicular access to the drainages in this area is often limited, but can be nonexistent and unsafe after heavy rain.

Schedule of initial monitoring:

Monitoring sediment chemistry in the vicinity of the Metro properties can begin within one month after the contract is finalized with a signed funding agreement, but the monitoring schedule is weather dependent. The storms likely to produce runoff and sediment deposition will probably happen during the spring and summer.